FREE AIHA RESOURCES FOR IMPROVING EXPOSURE RISK DECISIONS

FLA Fall Local Section Meeting
October 13, 2023

STEVEN D. JAHN, CIH, MBA, FAIHA®

jahnindustrialhygiene@gmail.com

BOARD FOR GLOBAL EHS CREDENTIALING
Certified Industrial Hygienist

Registered Specialist: Exposure Decision Analysis

#120102

AIHA Registry Programs ®

AIHA®
HEALTHIER WORKPLACES
A HEALTHIER WORLD

FREE AIHA RESOURCES FOR IMPROVING EXPOSURE RISK DECISIONS

Agenda:

- Overview of AIHA Improving OEHS Science and Practice Initiatives

- Improving Exposure Judgments
  - Why Important
  - Free Tools and Training
    - o What is available
    - o How does someone get access

- Q and A

QUICK OVERVIEW: AIHA IMPROVING OEHS SCIENCE AND PRACTICE INITIATIVES

A WORLD WHERE ALL WORKERS AND THEIR COMMUNITIES ARE HEALTHY AND SAFE

ADVANCING OUR SCIENCE AND PRACTICE TO BETTER PROTECT WORKERS AND COMMUNITIES

Four Exciting Initiatives:

Initiative	Purpose
AIHA – ACGIH Defining the Science	Advance our science to improve the ability of practitioners to protect workers and communities.
Principles to Good Practice	Define aspirational minimum practice performance expectations for ensuring acceptable worker protection.
State of the Art vs. Practice	Implement a continuous improvement strategy to close gaps between current practice and the state of the art and minimum standards of care.
AIHA – ACGIH Improving Exposure Judgements	Accelerate adoption of the use of IH statistical and other tools to improve the accuracy of worker exposure assessments.

Learn More Here

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AIHA GUIDELINE FOUNDATION STANDARDS OF CARE INITIATIVE

- The protection of workers and communities depends on the performance of risk management programs. As currently implemented, the effectiveness of those risk protection programs is highly variable, resulting in excessive risk for many workers and communities.

- This effort seeks to elevate the performance of all risk management programs, especially those which are underperforming, by documenting a summary of minimum expected standards of care or performance for critical aspects of risk management programs and practices.

A WORLD WHERE ALL WORKERS AND THEIR COMMUNITIES ARE HEALTHY AND SAFE

AIHA GUIDELINE FOUNDATION PRINCIPLES OF GOOD PRACTICE INITIATIVE

Goal:

Document a concise, easy to use summary of minimum recommended global standards of care for the professional practice of OEHS that incorporate best risk management practices whenever feasible.

Public Web Page

PGP Currently Under Development

Round 1:
- Noise and Hearing Conservation **– In Process**

Round 2:
- Occupational Exposure Assessment **– Final Draft Complete**
- Respiratory Protection Program
- Control Banding
- Management

OCCUPATIONAL EXPOSURE ASSESSMENT STANDARD OF CARE

Sections:

- Scope & Objectives
- Program Management
- Basic Characterization
- Occupational Exposure Limits
- Similar Exposure Groups (SEGs)
- Exposure Judgments
- Monitoring Practices
- Non-Recurring Operations
- Health Hazard Controls
- Medical Surveillance
- Communication & Training
- Reassessments
- Control Banding
- Performance Measurement
- Recordkeeping

OCCUPATIONAL EXPOSURE ASSESSMENT PRINCIPLES OF GOOD PRACTICE

PGP Section	Selected Key Content
Scope & Objectives	• Assess and control all chemical, physical and biological exposures for all workers across all workdays
Program Management	• Written program • Under direction of an industrial hygienist experienced and trained in exposure assessment
Basic Char.	• Critical information for characterizing exposures is documented for the workplace
Occupational Exposure Limits	• Authoritative or internal OELs are used for exposure judgments • Regulatory OELs are used if lower than authoritative or internal OELs
SEGs	• The workforce is stratified into similar exposure groups (SEG).
Exposure Judgments	• Exposure are acceptable if the 95th %ile is less than the OEL with 70% confidence (95% confidence best practice) • An AIHA Exposure Control Category (ECC) and certainty rating are selected for each air contaminant and noise SEG • The exposure profile for each SEG is judged acceptable or unacceptable
Monitoring Practices	• 3+ baseline samples are collected for each SEG initially rated ECC of 2 or 3 • Baseline sample data are analyzed using statistics to update the exposure category and the certainty rating • 3+ additional baseline samples are collected for SEGs with updated ECC of 2 or 3 having low or medium certainty
Non-recurring Ops	• Non-recurring operations are anticipated, prospectively assessed, and controlled
Health Hazard Controls	• Initially, SEGs judged unacceptable (ECC = 4) are quickly controlled • Enhanced permanent controls (higher on the hierarchy) are sought in a prioritized manner
Med. Surveillance	• Medical surveillance is provided to workers in ECC 3 and 4 where protocols are available
Com. & Training	• Findings and recommendations are reported in an effective and timely fashion
Reassessments	• Management of change procedures are established to provide notification of newly planned changes in the workplace, workforce, or environmental agents
Control Banding	• Control banding approaches are considered for use in the exposure assessment process
Perf. Meas.	• Performance measures are identified, tracked, and communicated to stakeholders
Recordkeeping	• Exposure assessment records are maintained indefinitely

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IMPROVING EXPOSURE JUDGEMENT ACCURACY

Improve Practice to Align with Current Science

Drive a significant shift in the OEHS practice paradigm: from one where tools and activities to improve exposure judgment accuracy and interpretation are rarely or sporadically used, to one where their use is routine and expected.

Public Web Page

IMPROVING EXPOSURE JUDGEMENT ACCURACY
WHY IMPORTANT?

Effective and Efficient Exposure Risk Management

Effective:

Ensure that no worker has unacceptable exposures

Efficient:
Do it for minimum cost

What if Our Exposure Assessment is Wrong?

If We Underestimate the Exposure?

- Increased Risk to Employees

If We Overestimate the Exposure?

- Unnecessary Constraints for Employees and Production
- Unnecessary Expenditures for Controls

Well-Designed Exposure Risk Management Strategy	
We Want:	**We Don't Want:**
Good Data	Bad Data
To Be Effective	To Not Be Protective
To Be Efficient	To Waste Resources
No Biases	Biases (High or Low)
Low Uncertainty	High Uncertainty
Correct Decisions	**Wrong Decisions**

Exposure Risk Decisions: How Accurate Are We?

Exposure Rating Category**	Recommended Control
0 (<1% of OEL)	No action
1 (<10% of OEL)	Procedures and Training; General Hazard Communication
2 (10-50% of OEL)	+ Chemical Specific Hazard Communication; Periodic Exposure Monitoring,
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4 (>100% of OEL)	+ Implement Hierarchy of Controls; Monitoring to Validate Respirator Protection Factor Selection.
Multiples of OEL (>500% of OEL or others based on respirator APF)	+Immediate Engineering Controls or Process Shut Down, Validate Acceptable Respirators

** Decision statistic = 95th percentile

Exposure Risk Decisions:
How Accurate Are We?
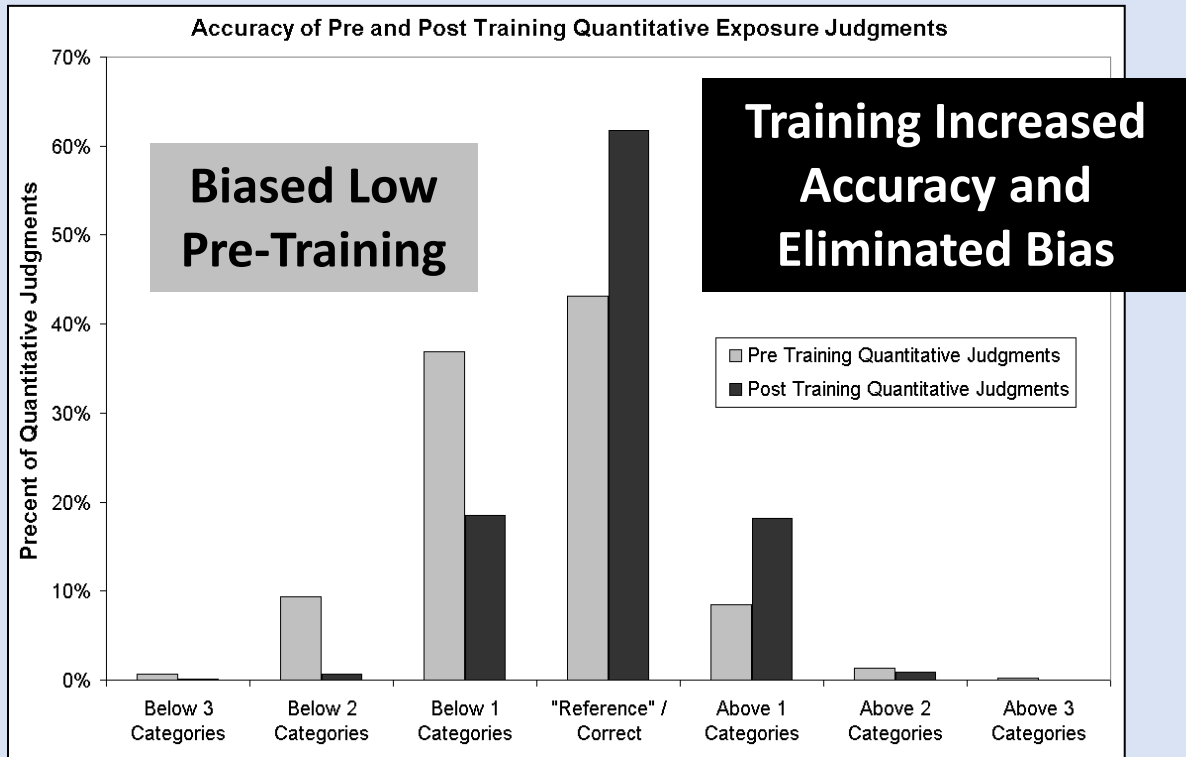
With Monitoring Data . . .

Sample Results (ppm)
18
15
5
8
12

?

?

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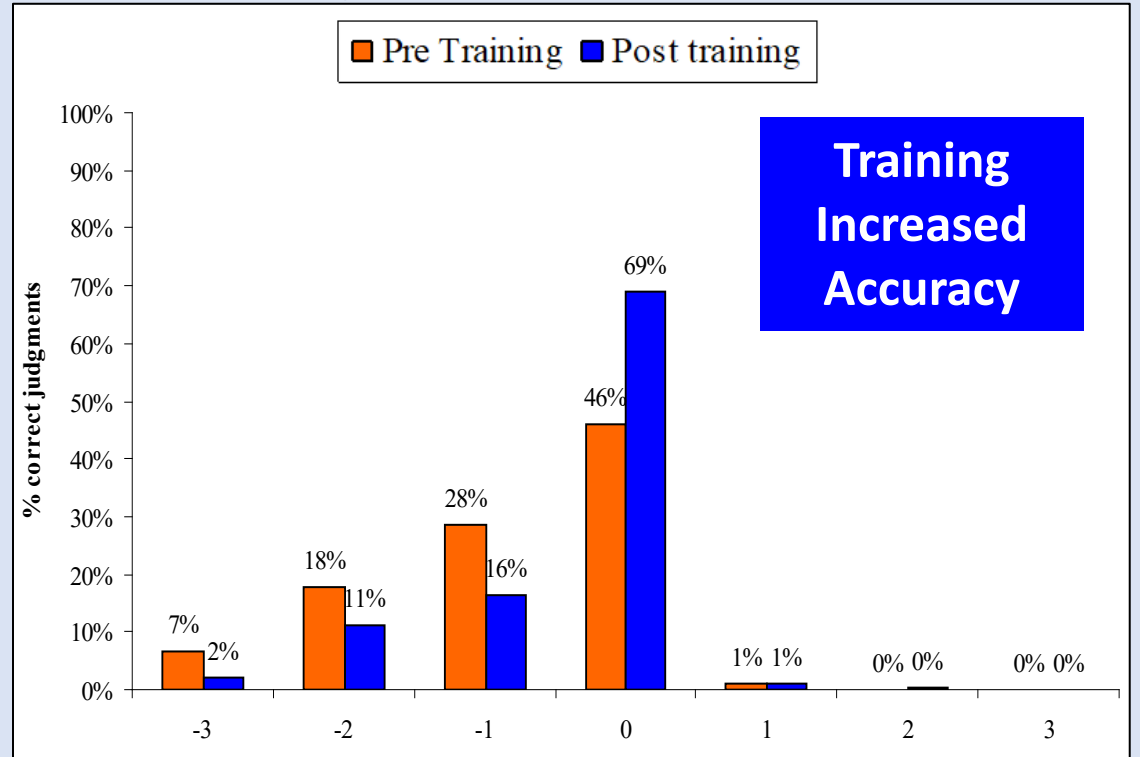
JUDGEMENT ACCURACY PRE- AND POST- STATISTICAL TRAINING

BASED ON MONITORING DATA

Video Tasks

Accuracy of Pre and Post Training Quantitative Exposure Judgments

Biased Low Pre-Training

Training Increased Accuracy and Eliminated Bias

P. Logan, G. Ramachandran, J. Mulhausen and P. Hewett "Occupational Exposure Decisions: Can Limited Data Interpretation Training Help Improve Accuracy?". Annals of Occupational Hygiene - 2009
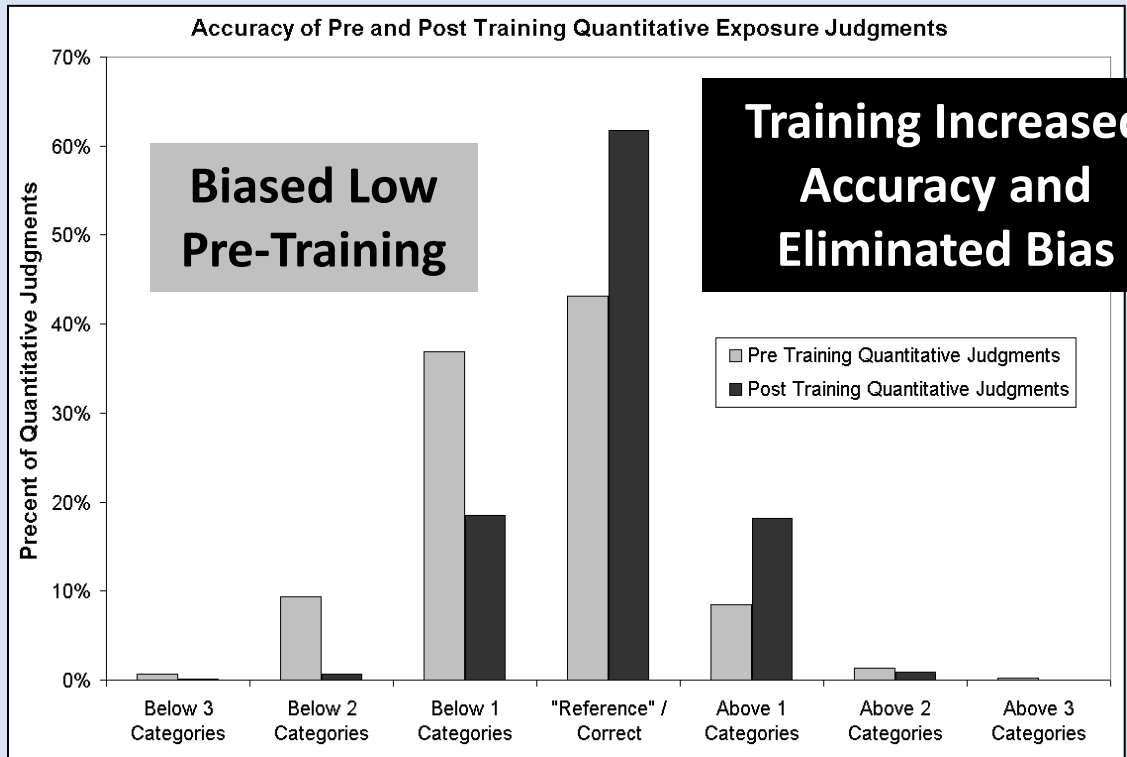
Actual Workplace Assessments

Training Increased Accuracy

Vadali, Ramachandran, Mulhausen & Banerjee (2012): "Effect of Training on Exposure Judgment Accuracy of Industrial Hygienists", Journal of Occupational and Environmental Hygiene, 9:4, 242-256

JUDGEMENT ACCURACY
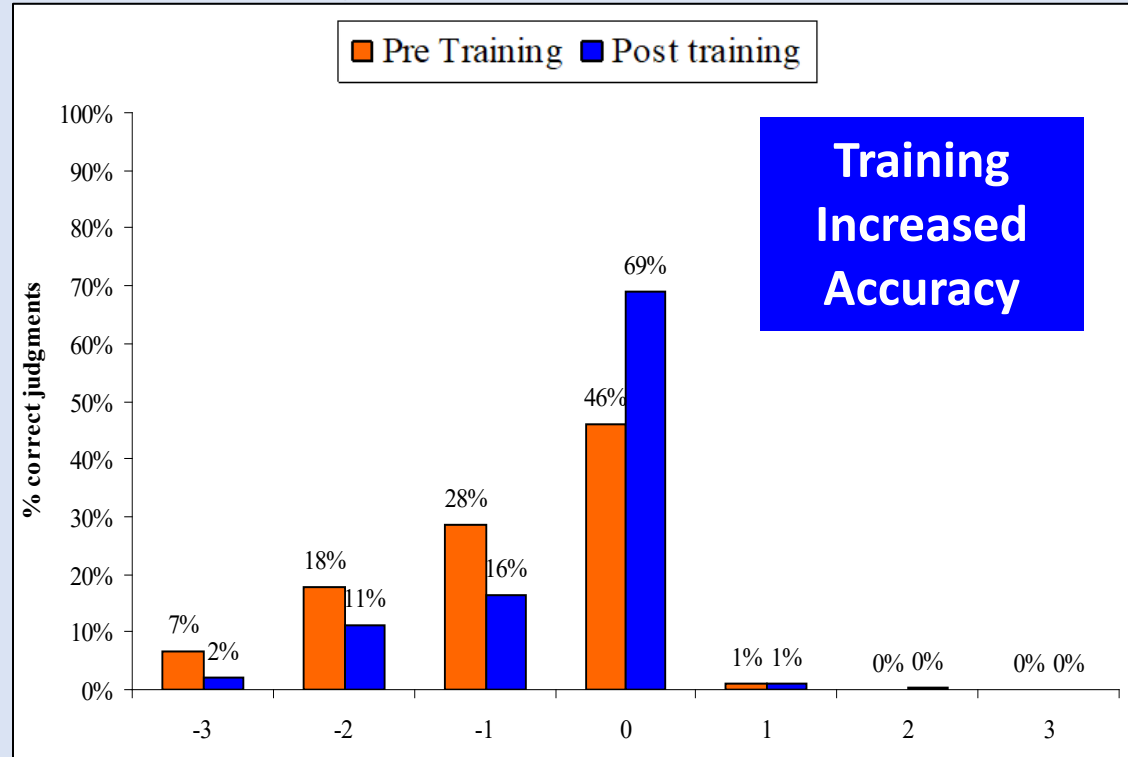## PRE- AND POST- STATISTICAL TRAINING

BASED ON MONITORING DATA

Before Statistical Training:
Poor Accuracy & Underestimation Bias

Video Tasks

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Monitoring-Based Exposure Judgments

- Bad News
  - Often incorrect
- Good News
  - Simple statistical training improves judgments
- GREAT NEWS!!!
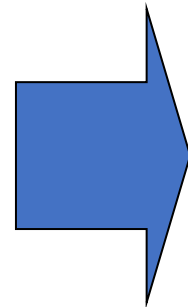 - Using statistical tools when we make monitoring-based exposure judgments will greatly improve accuracy
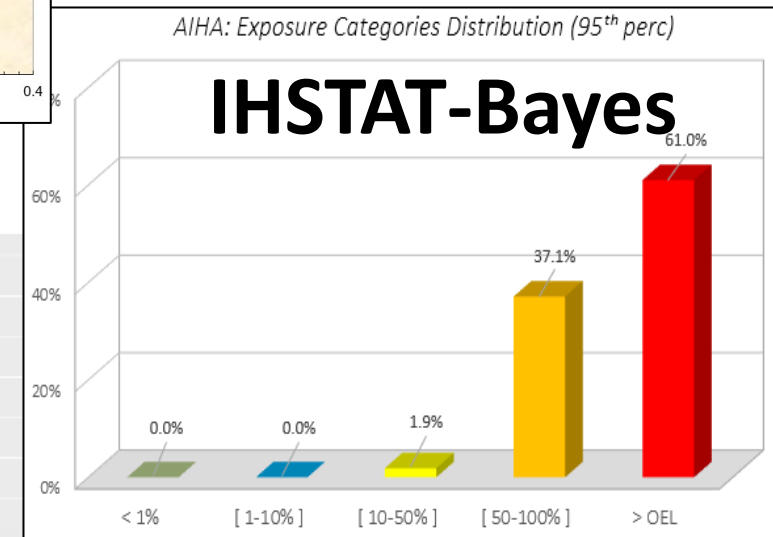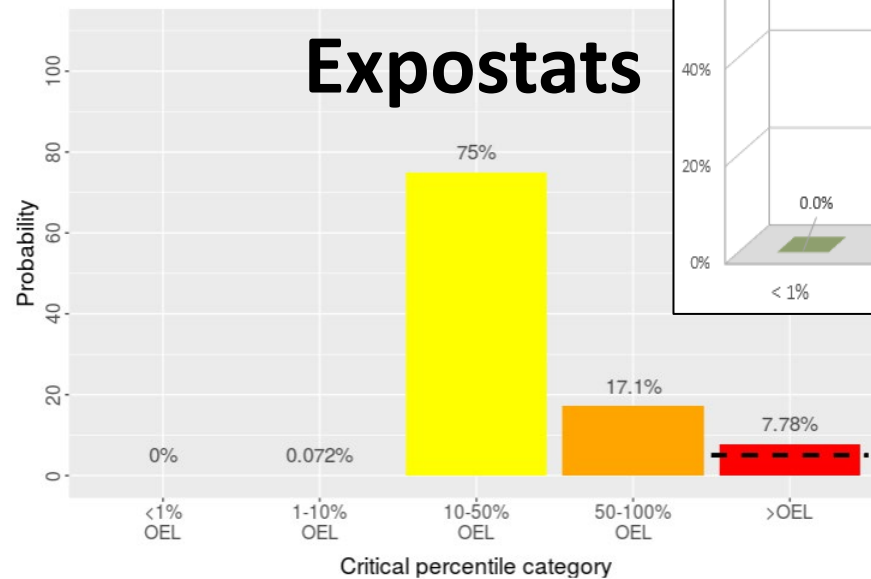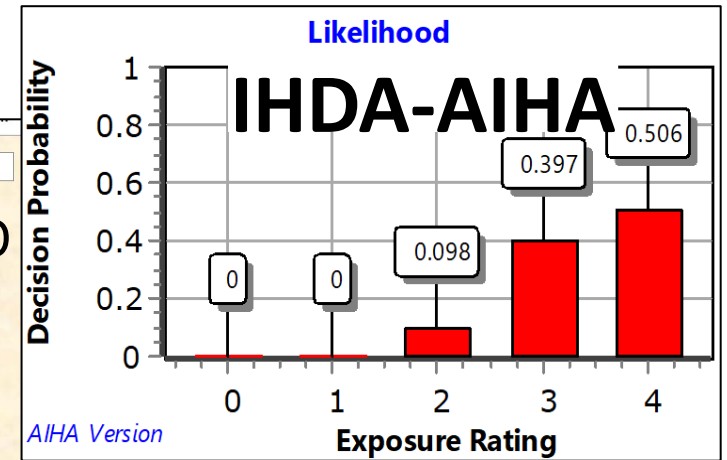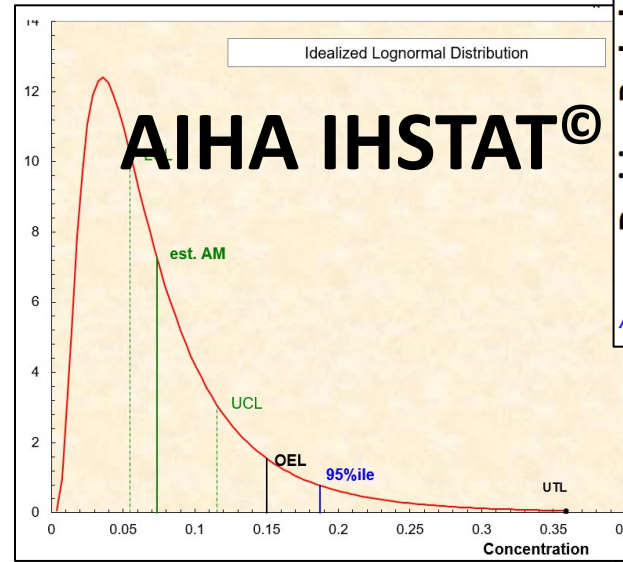
AIHA IHSTAT©

IHDA-AIHA

IHSTAT-Bayes

Expostats

Statistical Approaches to Understanding the Exposure Profile

Ethanol
OEL = 1000 ppm

Monitoring Results:

215	ppm
52	ppm
395	ppm
700	ppm
75	ppm

Traditional IH Statistics
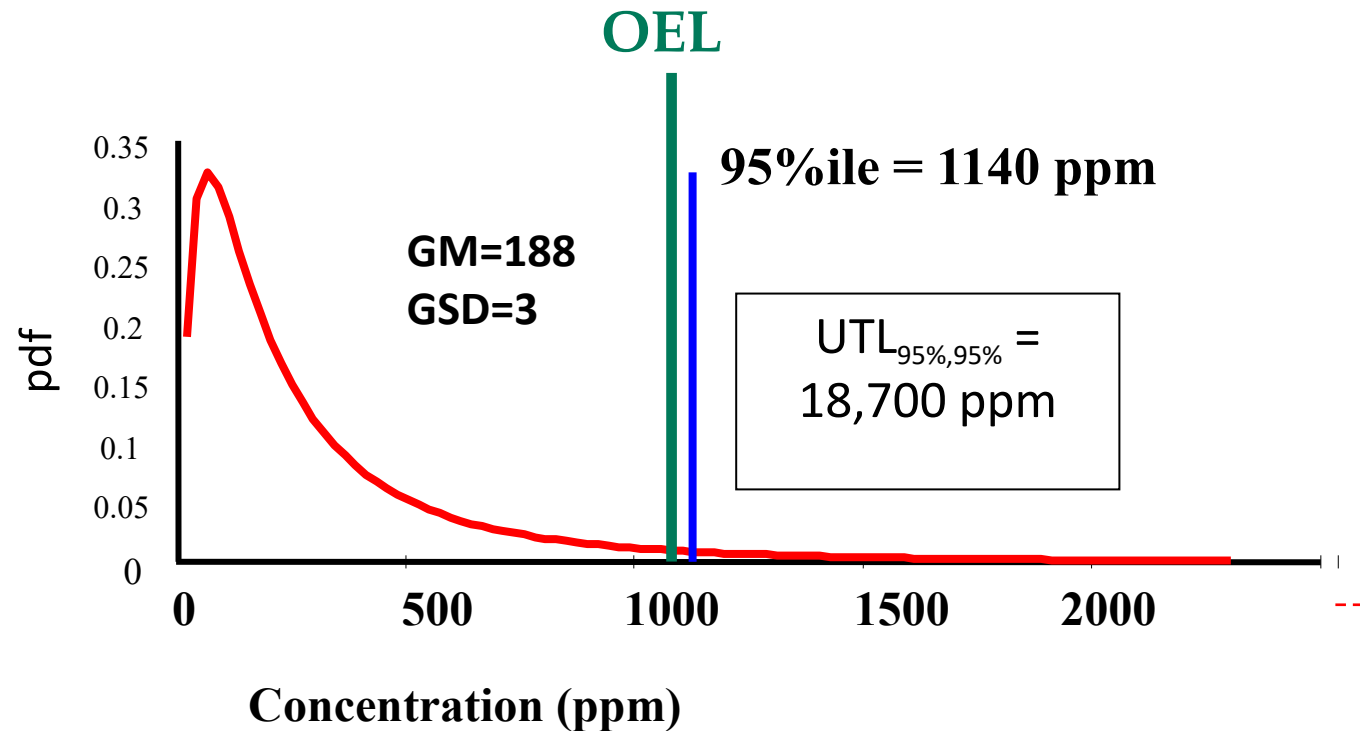
OEL

95%ile = 1140 ppm

GM=188
GSD=3

$UTL_{95\%,95\%} = 18,700$ ppm

pdf

Concentration (ppm)

Statistical Approaches to Understanding the Exposure Profile

Ethanol

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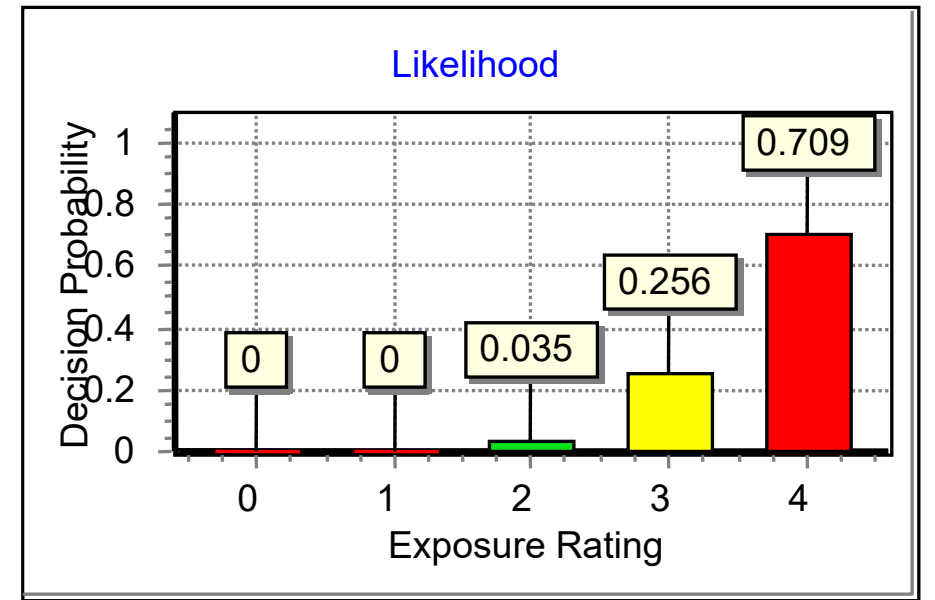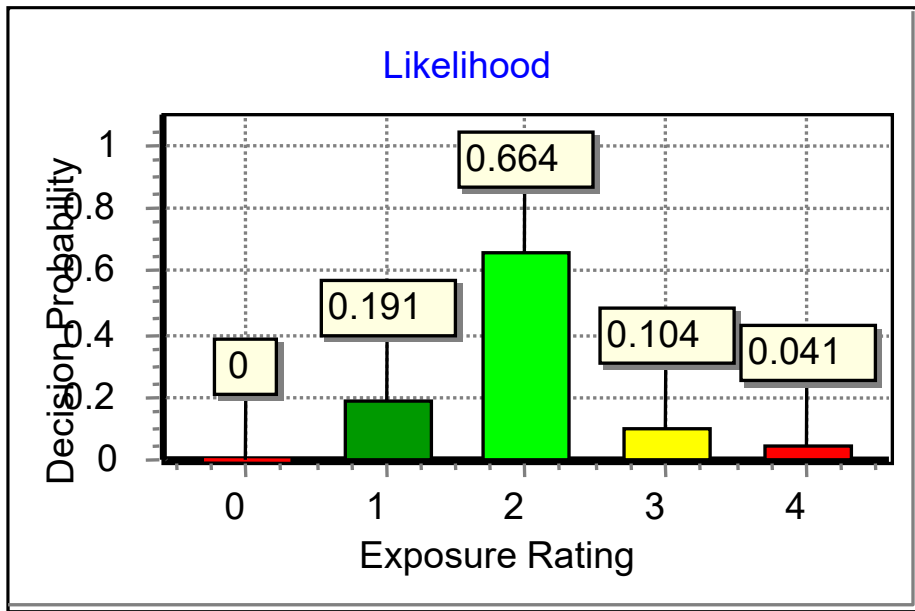
215	ppm
52	ppm
395	ppm
700	ppm
75	ppm

Bayesian Decision Analysis (BDA)

OEL

Likelihood that 95%ile falls into indicated Exposure Rating Category

- <1%OEL: 0
- <10% OEL: 0
- 10 – 50%: 0.087
- 50 – 100%: 0.4
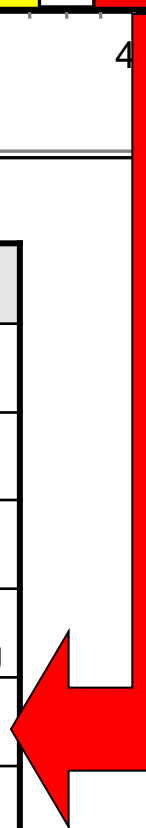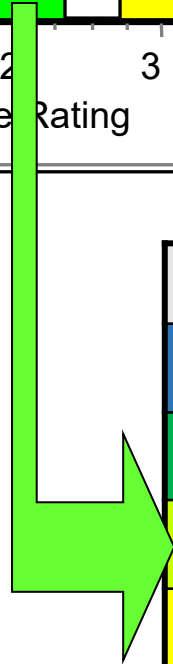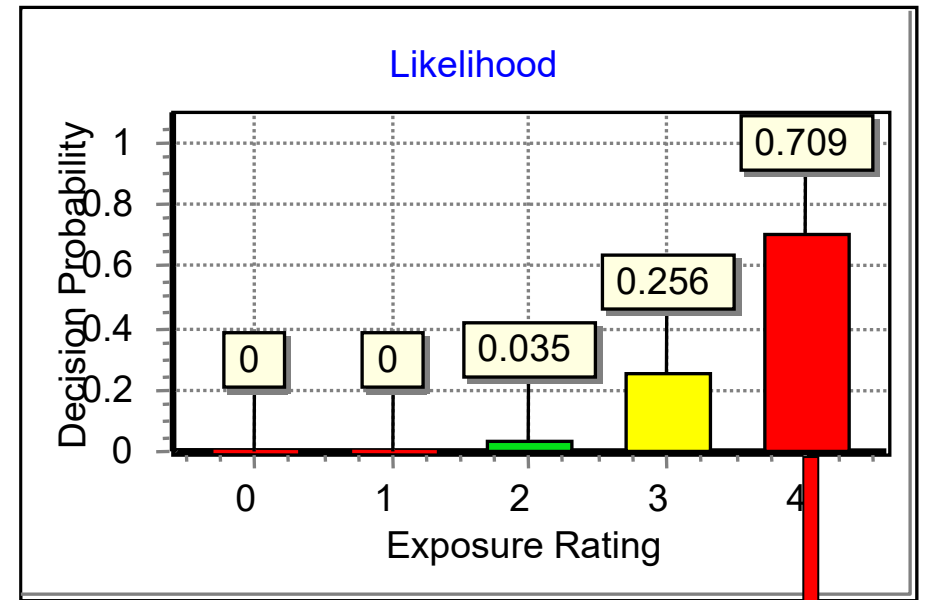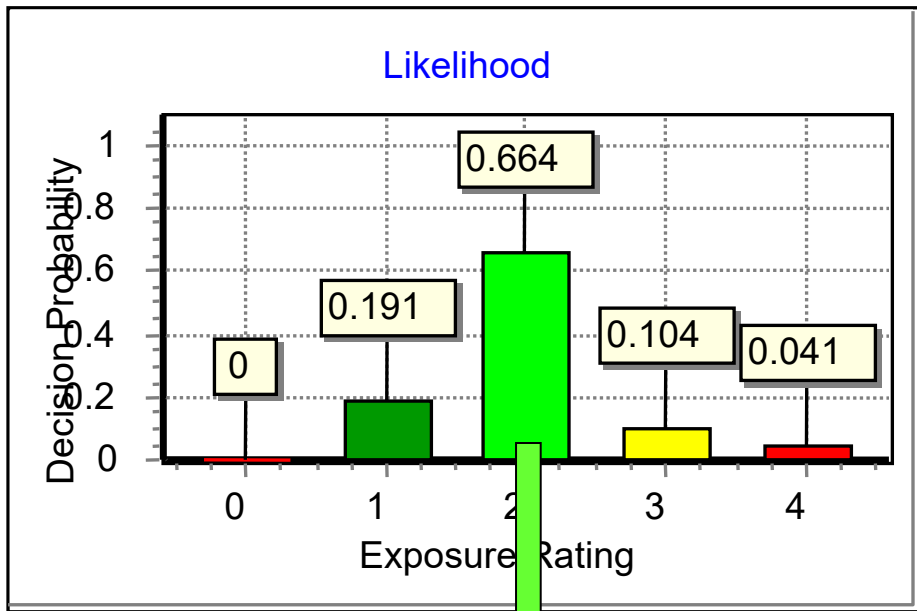- >100% OEL: 0.513

Exposure Rating Category
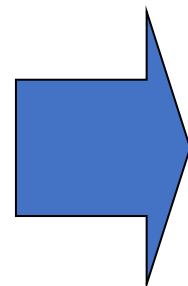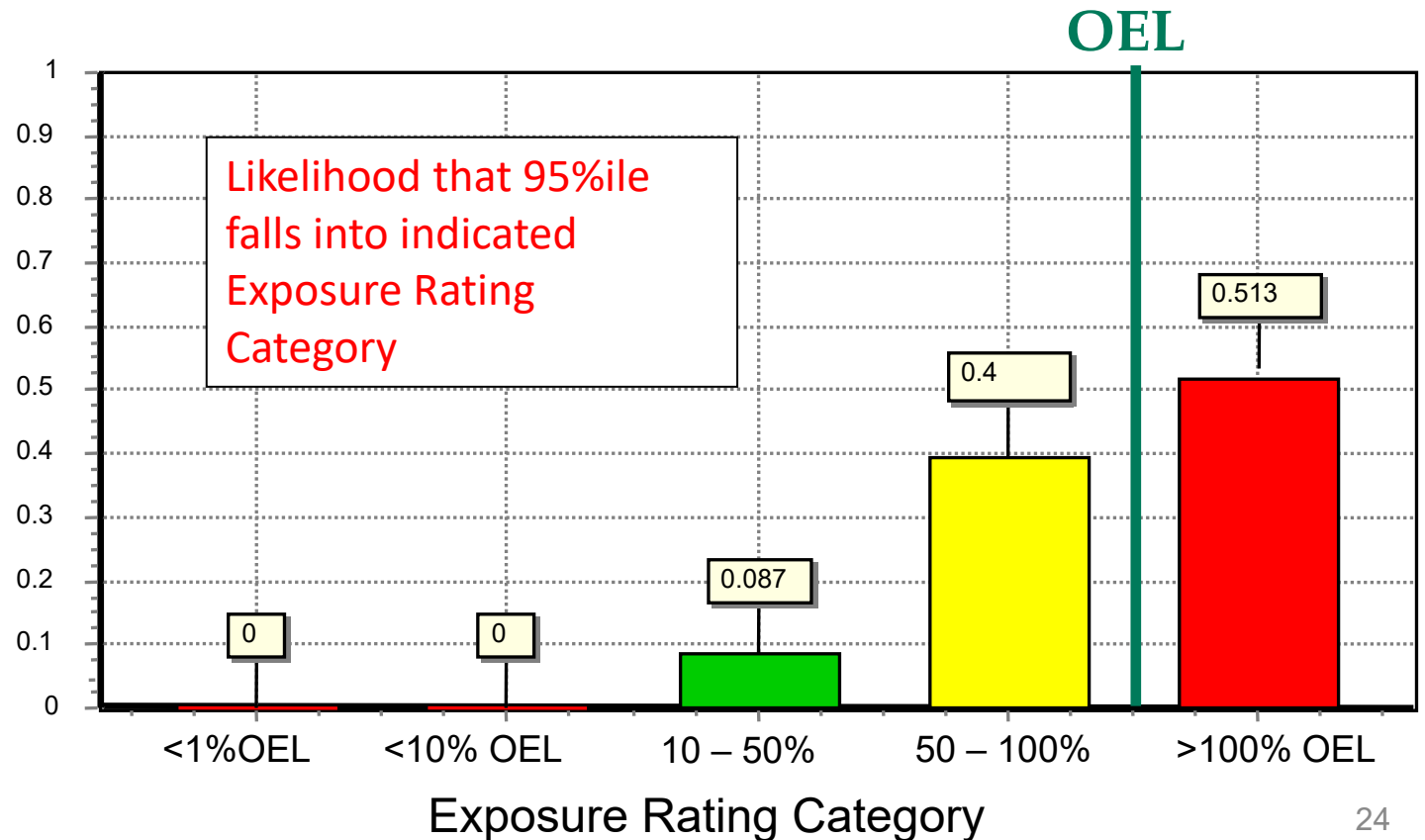
Easier to Interpret!
Easier to communicate!

- BDA output gives probabilities - easier for people to understand than traditional confidence intervals

- The uncertainty associated with small data sets shows up clearly so risk can be better communicated

Follow-up is Straightforward

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Advantages of Bayesian Statistics

- More Intuitive Depiction of Exposures and Uncertainty than Traditional Statistics

- Direct Alignment with AIHA Exposure Rating and Control Categories

- Easy to Communicate

- Great for small monitoring data sets . . . Including n=1

- Elegant Handling of Censored Data (Non-Detects) . . . Including Fully Censored Data

Sample Size n=1

OEL = 1 ppm

Sample Results (ppm)
0.65

Fully Censored Data

OEL = 100 ppm

Sample Results (ppm)
<5
<3.3
<12
<9
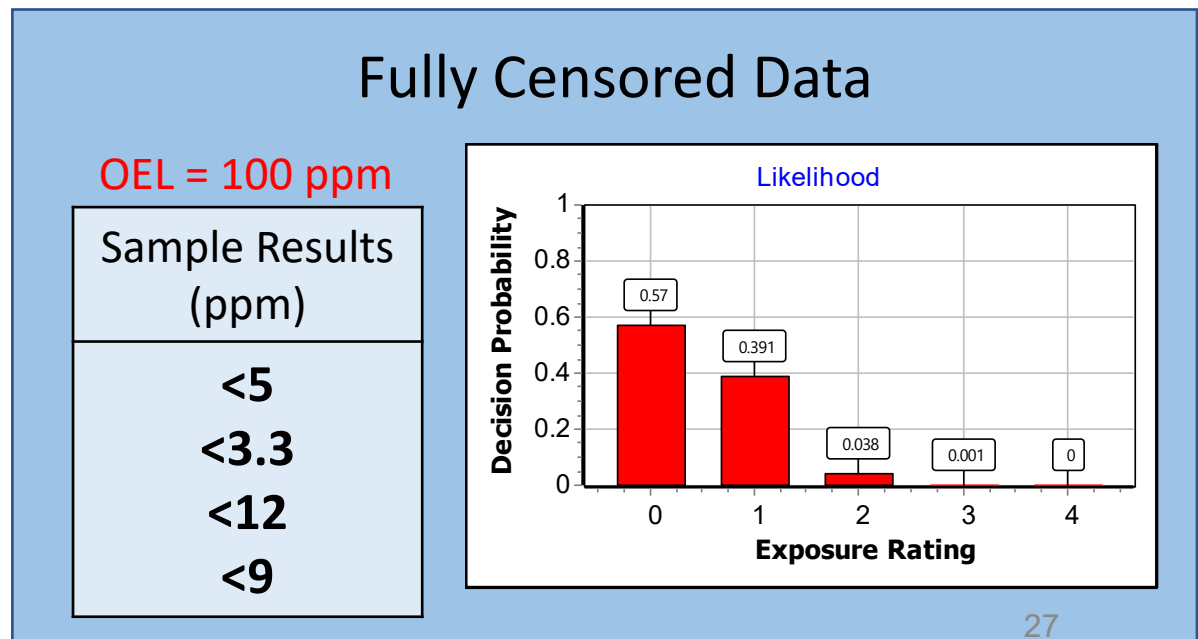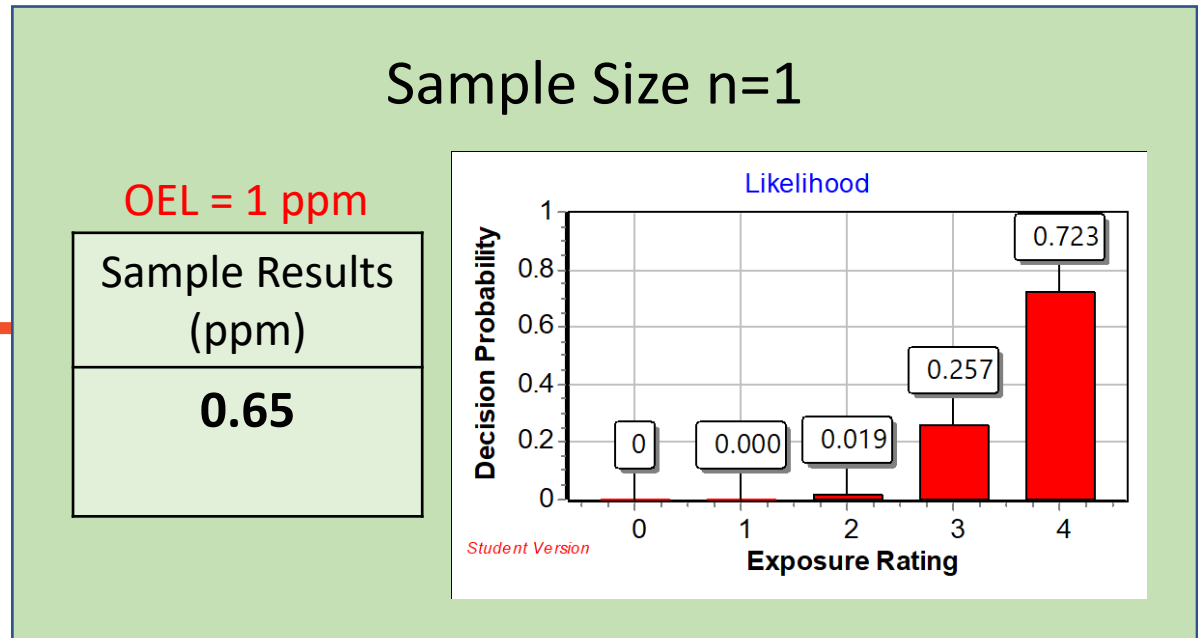
Exposure Risk Decisions:
How Accurate Are We?

Without Monitoring Data . . .

Process Operator #1

?
?

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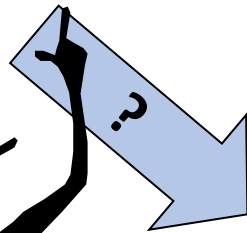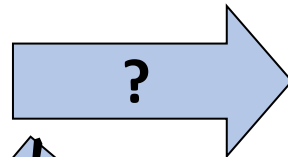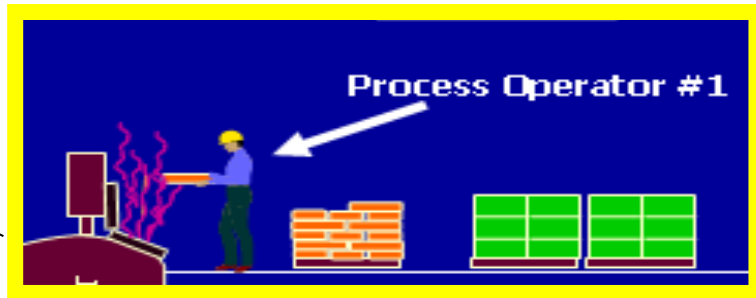
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PRE- AND POST- STATISTICAL TRAINING

NO MONITORING DATA AVAILABLE

Video Tasks
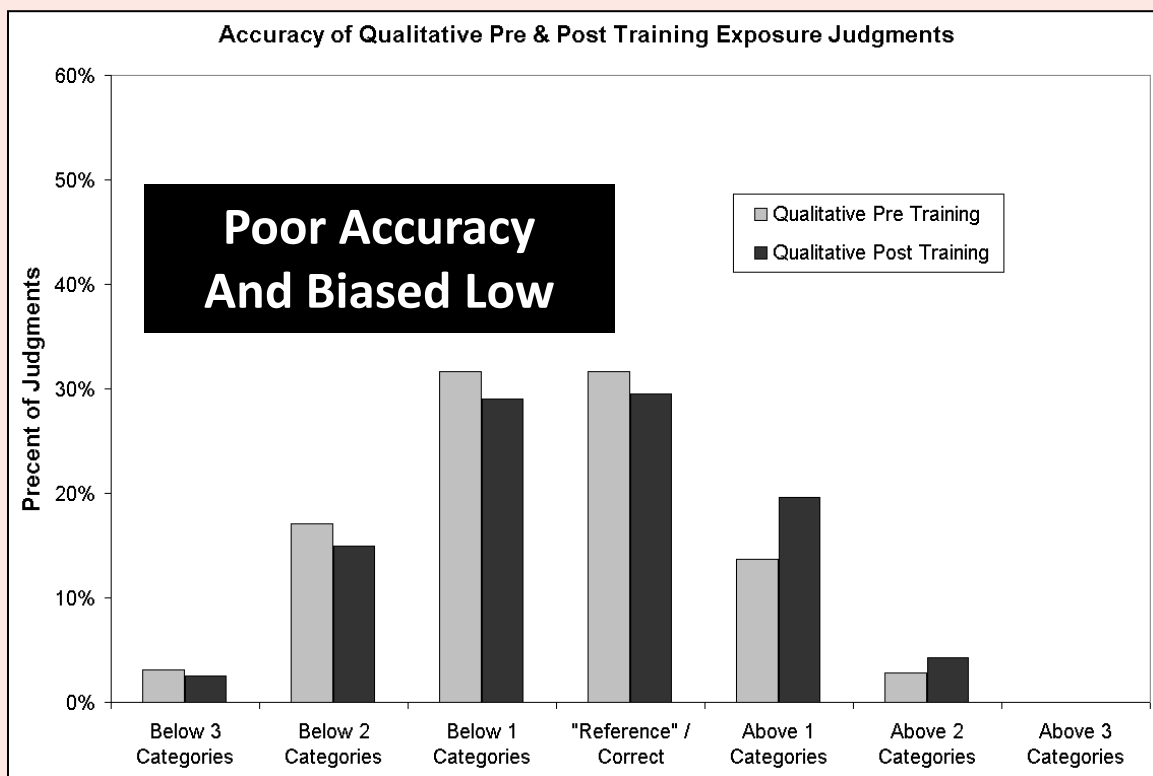
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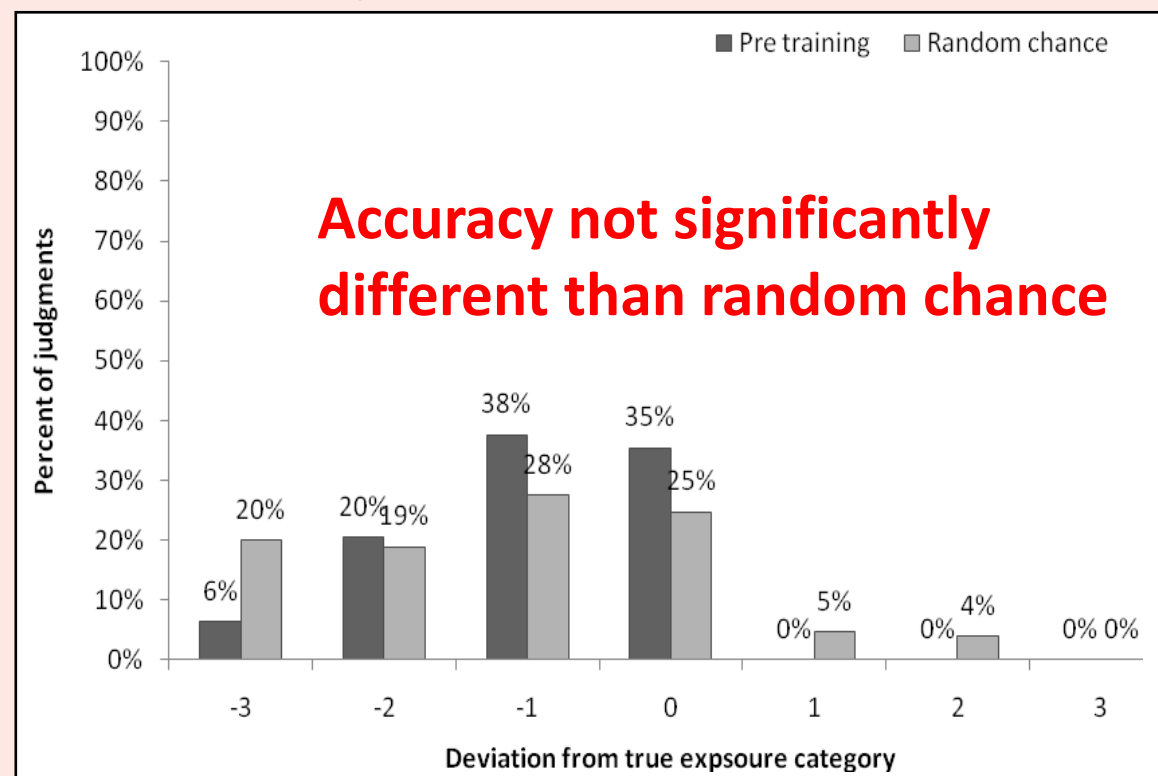
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JUDGEMENT ACCURACY PRE- AND POST- STATISTICAL TRAINING

NO MONITORING DATA AVAILABLE

Poor Accuracy & Underestimation Bias

Video Tasks

Accuracy of Qualitative Pre & Post Training Exposure Judgments

Poor Accuracy And Biased Low

Legend: Qualitative Pre Training, Qualitative Post Training

X-axis: Below 3 Categories, Below 2 Categories, Below 1 Categories, "Reference" / Correct, Above 1 Categories, Above 2 Categories, Above 3 Categories

Y-axis: Precent of Judgments

P. Logan, G. Ramachandran, J. Mulhausen and P. Hewett "Occupational Exposure Decisions: Can Limited Data Interpretation Training Help Improve Accuracy?". Annals of Occupational Hygiene - 2009

Actual Workplace Assessments

Legend: Pre training, Random chance

Accuracy not significantly different than random chance

Values by deviation from true exposure category:
-3: 6%, 20%
-2: 20%, 19%
-1: 38%, 28%
0: 35%, 25%
1: 0%, 5%
2: 0%, 4%
3: 0%, 0%

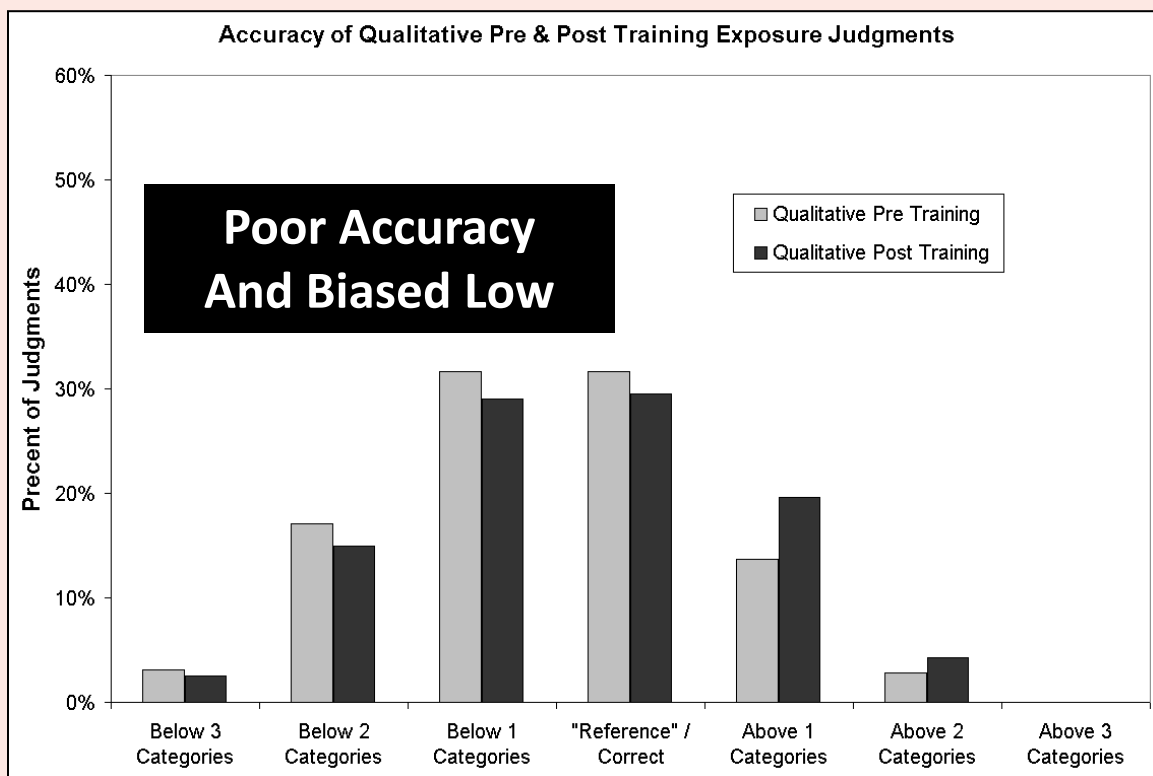X-axis: Deviation from true expsoure category

Y-axis: Percent of judgments

Vadali, Ramachandran, Mulhausen & Banerjee (2012): "Effect of Training on Exposure Judgment Accuracy of Industrial Hygienists", Journal of Occupational and Environmental Hygiene, 9:4, 242-256

JUDGEMENT ACCURACY
PRE- AND POST- CHECKLIST TRAINING AND USE
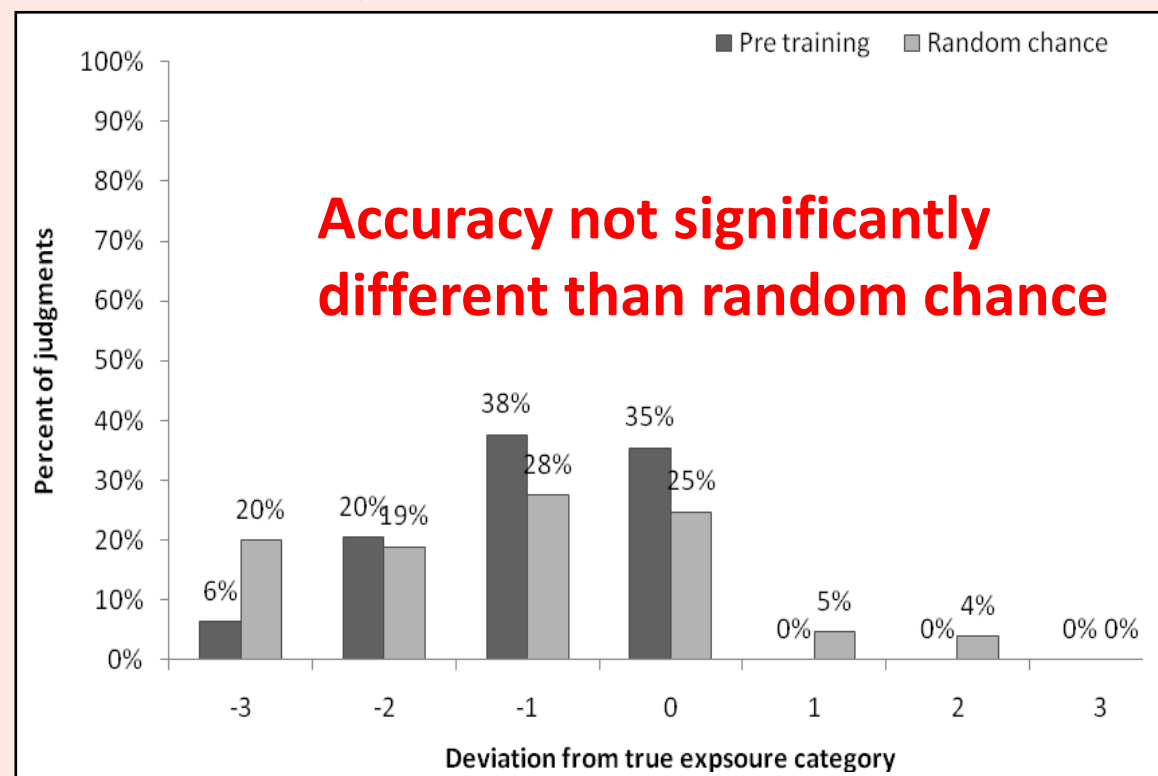
NO MONITORING DATA AVAILABLE

Practicing OSH Professionals

Pre-training accuracy not significantly different from random chance.

Accuracy Doubled with Checklist Training and Use

Legend:
- Baseline n = 61
- Checklist n = 115
- Random chance

X-axis categories: minus 3, minus 2, minus 1, accurate, plus 1, plus 2, plus 3

Y-axis: Percent Accuracy (0% to 70%)

Susan F. Arnold; Mark Stenzel; Daniel Drolet; Gurumurthy Ramachandran; "Using Checklists and Algorithms to Improve Qualitative Exposure Judgment Accuracy", *Journal of Occupational and Environmental Hygiene* 2016, 13, 159-168.

JUDGEMENT ACCURACY
PRE- AND POST- CHECKLIST TRAINING AND USE

NO MONITORING DATA AVAILABLE

Before Checklist Training and Use:
Poor Accuracy & Underestimation Bias

Practicing OSH Professionals

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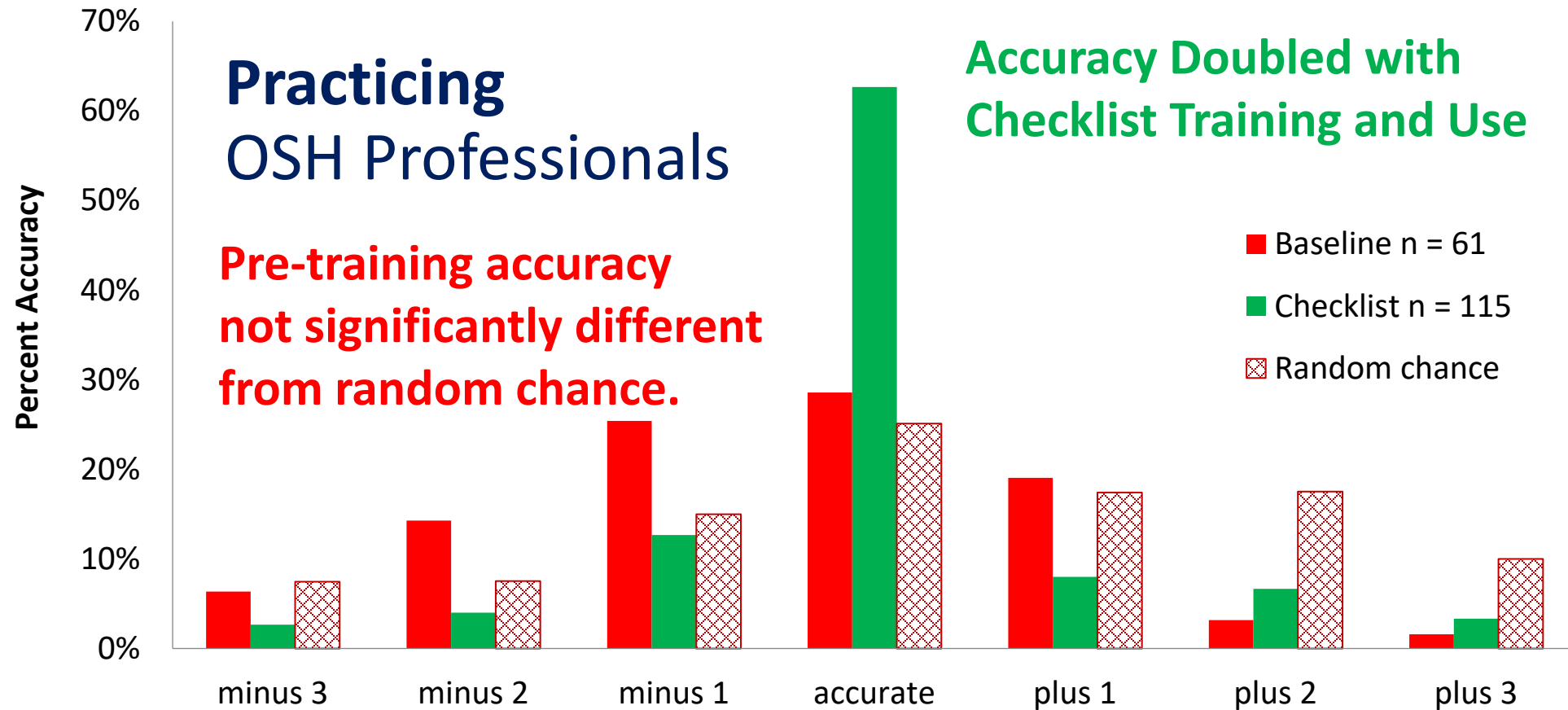X-axis categories: minus 3, minus 2, minus 1, accurate, plus 1, plus 2, plus 3

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How Can We Improve Our Qualitative Judgments?

Learn From Our Colleagues in Cognitive Psychology . . .

Work in Other Disciplines: Physicians, Pilots

- Humans are more often biased and inaccurate than we know
- Our "gut" is wrong much more often than we know . . . or want to know
- As individuals we think we are the accurate one, it is "the person next to us that isn't so good"

How Can We Improve Our Qualitative Judgments?

The Key is "Slow Thinking" (Daniel Kahneman's *Thinking Fast and Slow**)

Fast Thinking:
- Reflexive, quick, emotion-driven and instinctive – brain stem & hormones
- Good for the many routine decisions that we make every day.
- **Reliance on emotion and individual experiences can lead to biases and faulty decision making.**

Slow Thinking:
- Deliberate and logical. Learned algorithms, data analysis.
- Requires energy and conscious focus.
- **Serves us well when we have important decisions to make.**

*Kahneman, Daniel. *Thinking, Fast and Slow*. United Kingdom: Farrar, Straus and Giroux, 2011.

How Can We Improve Our Qualitative Judgments?

- Systematic Exposure Decision Process

- Document Results and Rationale for Judgments
  e.g. Checklist Tool

- Document Exposure Determinants
  e.g. Modeling

- Discussion with Colleagues

- Focused Training, Coaching, and Practice

- **Accurate Feedback Mechanisms**
  e.g. Compare initial qualitative judgment to final result from the statistical analysis of monitoring data

Implement The AIHA Strategy!

SEG	Agent / Chemical	OEL	Initial Exposure Rating	Initial Certainty Rating	Final Exposure Rating	Final Certainty Rating
				↔		
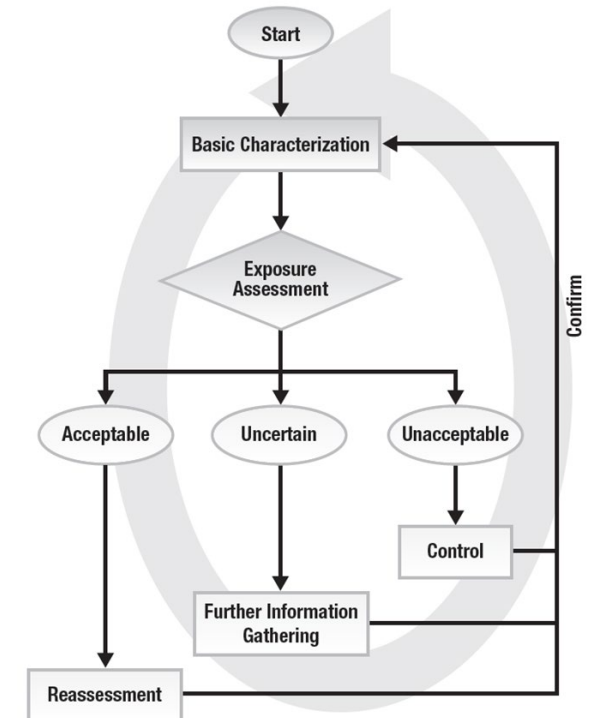
FREE RESOURCES
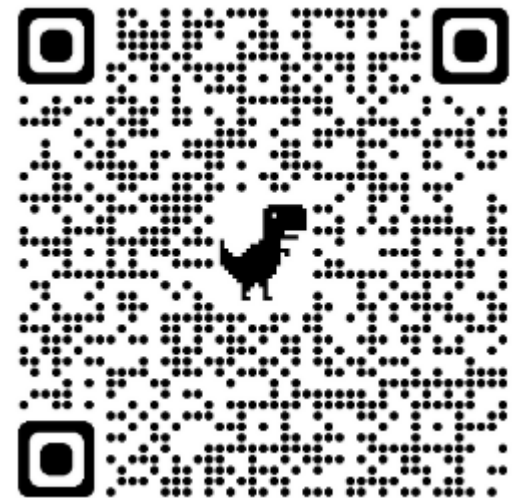## TOOLS

Free IH Statistical Analysis Tools

- **Traditional Statistics**
  - **AIHA IHSTAT$^{©}$ -** Excel application that calculates various exposure statistics, performs goodness of fit tests, and graphs exposure data.

- **Bayesian Statistics**
  - **IHDA-AIHA –** Stand-alone application for the analysis and interpretation of exposure monitoring datasets using traditional and Bayesian statistics.
  - **Expostats** -Toolbox of web applications for the interpretation of IH measurements using Bayesian statistics.
  - **IHSTAT-Bayes** – Excel-based application that calculates various exposure statistics using a Bayesian model.

  All available from AIHA: HERE

FREE TOOLS

Free AIHA Exposure Assessment Tools

- **IH/OEHS Exposure Scenario Tool (IHEST)**
  Excel tool to aid Basic Characterization (BC)

- **IHSkinPerm©**
  Excel tool for estimating dermal absorption.

- **Basic Exposure Assessment (EA) and Sampling Spreadsheet**
  Excel template for entering EA/BC and sampling data.

- **Toxico-kinetic Extended Shift OEL Adjustment**
  Excel tool for adjusting OELs using the Hickey and Reist approach.

- **Structured Deterministic Model 2.0 (Formerly "Checklist Tool")**
  Excel tool for estimating potential airborne exposures.

- **IHMOD 2.0©**
  Excel-based mathematical modeling spreadsheet

MORE FREE TOOLS!!

https://www.aiha.org/public-resources/consumer-resources/apps-and-tools-resource-center/aiha-risk-assessment-tools

FREE RESOURCES
TRAINING

FREE WEBINAR ON STATISTICAL ANALYSIS TOOLS

Making Accurate Exposure Risk Decisions

FREE!

Taught by Leading Experts

8 Contact Hours !!

Paul Hewett Ph.D, MS, CIH, FAIHA
Developed IH Data Analyst (IHDA) for Bayesian statistical analysis of monitoring data

Jérôme Lavoué Ph.D., MS
Led the development of Expostats for Bayesian statistical analysis of monitoring data

John Mulhausen Ph.D., MS, CIH, CSP, FAIHA
Authored the initial version of IHSTAT® for traditional statistical analysis of monitoring data

Andrew D. Perkins MS, CIH, CSP, COHC
Experienced in the application of statistical tools in accordance with the AIHA Exposure Assessment Strategy

https://www.aiha.org/education/elearning/online-courses/making-accurate-exposure-risk-decisions

FREE RESOURCES
COMPETENCY ASSESSMENT

Exposure Decision Analysis: Competency Assessment

Registered Specialist: Exposure Decision Analysis
#120102
AIHA Registry Programs ®

Exposure Decision Criteria
- Allowable Exceedance
- Needed Confidence
- Use of Exposure Categories

Traditional Industrial Hygiene Stats
- Properties of a lognormal distribution
- Upper percentile estimate calculation & interpretation
- Tolerance Limit calculation & interpretation

Bayesian Decision Analysis (BDA)
- Properties of a lognormal distribution
- Upper percentile estimate calculation & interpretation
- Tolerance Limit calculation & interpretation

Data and Similar Exposure Groups (SEGs)
- Rules for combining data
- Indications that a SEG may need refining

Decision Heuristics and Human Biases
- Common sources of bias in data interpretation and exposure assessment
- How to avoid bias in data interpretation

Exposure Data Interpretation
- Most likely exposure category given data
- Meet the certainty requirement given data

Techniques for Improving Professional Judgments
- Feedback loops (quantitative judgment > monitoring > qualitative judgment)
- Group judgment sessions
- Documentation of rationale
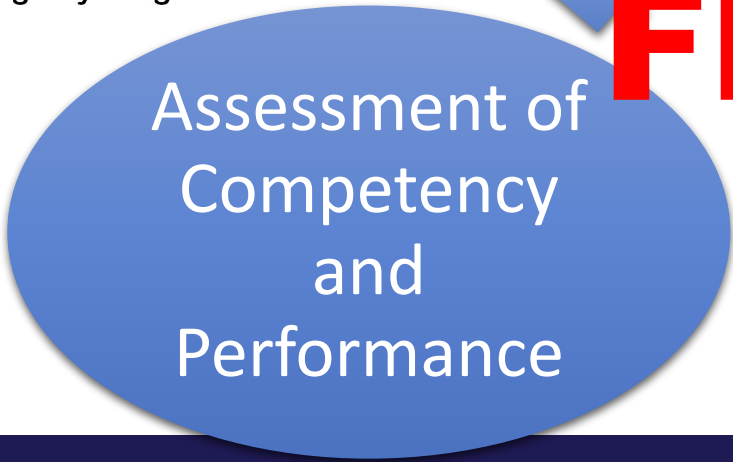- Break decisions into aggregate parts (Modeling)

Learn More Here

AIHA Registry PROGRAMS™

FREE
Demonstrate Competency and Performance

IMPROVING EXPOSURE DECISION ACCURACY: COMPLETE RESOURCE PACKAGE

FREE RESOURCES
ANYONE CAN ACCESS

Accessing the Free Tools and Training Materials
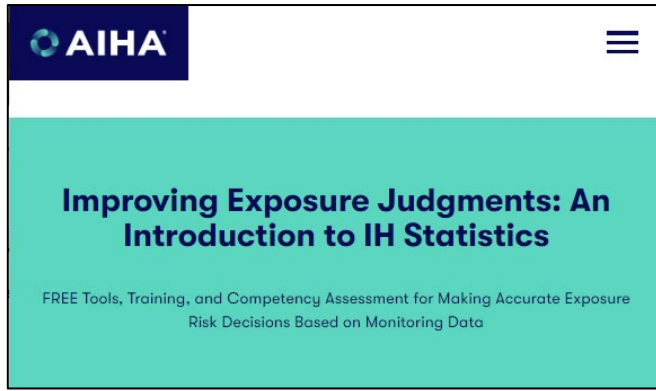
1. aiha.org

2. OEHS Professionals

3. Improving Exposure Judgments

Free Tools and Training Materials
Improving Exposure Judgments: An Introduction to IH Statistics

Click Here

What's Included:

- **Free Powerful and Easy-To-Use Statistical Tools.**
  - Access tools: click here.

- **Free Stand-Alone Online Webinar.**
  - Access webinar
  - Access topical outline of webinar

- **Free Online Independent Validation of Competency and Performance via the AIHA Exposure Decision Analysis Registry Exam.**
  - Exposure Decision Analysis Registry Program Information Pamphlet
  - Access Registry

- **Free Training Materials for Use by Anyone Conducting Virtual or In-Person Training.**
  - "Making Accurate Exposure Risk Decisions" webinar slides and resources
  - "Improving IH Exposure Judgments: Train-the-Trainer" PDC slides & resources

- **Four Roadmaps on How to Use the Free Materials**

Free Tools and Training Materials
Improving Exposure Judgments: An Introduction to IH Statistics

Four Roadmaps on How to Use the Free Materials

Roadmap #1:
Self-study using the standalone online training and assessment

https://www.aiha.org/public-resources/aiha-academic-portal/roadmap-1-self-study-using-the-standalone-online-training-and-assessment

Roadmap #2:
Instructor assigned independent study using the standalone online training and assessment

https://www.aiha.org/public-resources/aiha-academic-portal/roadmap-2-instructor-assigned-independent-study

Roadmap #3:
Integration of the materials into virtual or in-person classroom lecture programs

https://www.aiha.org/public-resources/aiha-academic-portal/roadmap-3-integration-of-training-materials-and-assessment-into-virtual-or-in-person-lecture-programs

Roadmap #4:
Hybrid approach that mixes self-study with focused in-person lecture programs

https://www.aiha.org/public-resources/aiha-academic-portal/roadmap-3-mixed-online-and-in-person-training-and-assessment

Free Tools and Training Materials
Improving Exposure Judgments: An Introduction to IH Statistics

ROADMAP #4: Mixed Online and In-Person Training and Assessment

1. **Teachers** review the free training materials from the webinar and from the Train-the-Trainer PDC.

2. **Teachers** select appropriate materials that emphasize key points and reinforce critical learning objectives for incorporation into their limited focus lecture and discussion program.

3. **Teachers** create an assignment for learners to complete steps 4 through 7 by a certain due date.

4. **Learners** download (and install if necessary) software for performing statistical analysis of data.

5. **Learners** complete the free "Making Accurate Exposure Risk Decisions" Webinar.

6. **Learners** complete the free "Practice Exam" associated with the webinar.

7. For missed practice exam questions, **learners** review the correct exam answers along with the appropriate sections in the webinar and provided worked examples to reinforce correct learning.

8. **Teachers** conduct lecture program focused on reinforcing key learnings from the webinar.

9. **Learners** use successful completion of the free Exposure Decision Analysis Registry Exam as a demonstration of learning objective competency and proficiency.

10. **Teachers** confirm demonstration of competency and proficiency via AIHA Registry list of Registered Specialists - Exposure Decision Analysis. Upon successful completion of the exam, learner's name will be featured on the AIHA Registry List of Registered Specialists: Exposure Decision Analysis.

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LEARN MORE

Learn More:

Papers - Bayesian Analysis :

- Hewett, P., Logan, P., Mulhausen, J., Ramachandran, G., and Banerjee, S.: "Rating Exposure Control using Bayesian Decision Analysis", Journal of Occupational and Environmental Hygiene, 3: 568–581, 2006
- Jérôme Lavoué, Lawrence Joseph, Peter Knott, Hugh Davies, France Labrèche, Frédéric Clerc, Gautier Mater, Tracy Kirkham, "Expostats: A Bayesian Toolkit to Aid the Interpretation of Occupational Exposure Measurements", Annals of Work Exposures and Health, Volume 63, Issue 3, April 2019, Pages 267–279

Papers – Improving Exposure Decision Accuracy

- Logan P., G. Ramachandran, J. Mulhausen, S. Banerjee, and P. Hewett "Desktop Study of Occupational Exposure Judgments: Do Education and Experience Influence Accuracy?" Journal of Occupational and Environmental Hygiene, 8:12, 746-758, 2011.
- Logan P., G. Ramachandran, J. Mulhausen, and P. Hewett:" Occupational Exposure Decisions: Can Limited Data Interpretation Training Help Improve Accuracy?" Annals of Occupational Hygiene, Vol. 53, No. 4, pp. 311–324, 2009.
- Vadali, M. G. Ramachandran, J. Mulhausen, S. Banerjee, "Effect of Training on Exposure Judgment Accuracy of Industrial Hygienists". Journal of Occupational & Environmental Hygiene. 9: 242–256, 2012.
- Arnold S., M. Stenzel, D. Drolet, G. Ramachandran; Journal of Occupational and Environmental Hygiene, 13, 159-168, 2016

Learn More:

- **Books:**
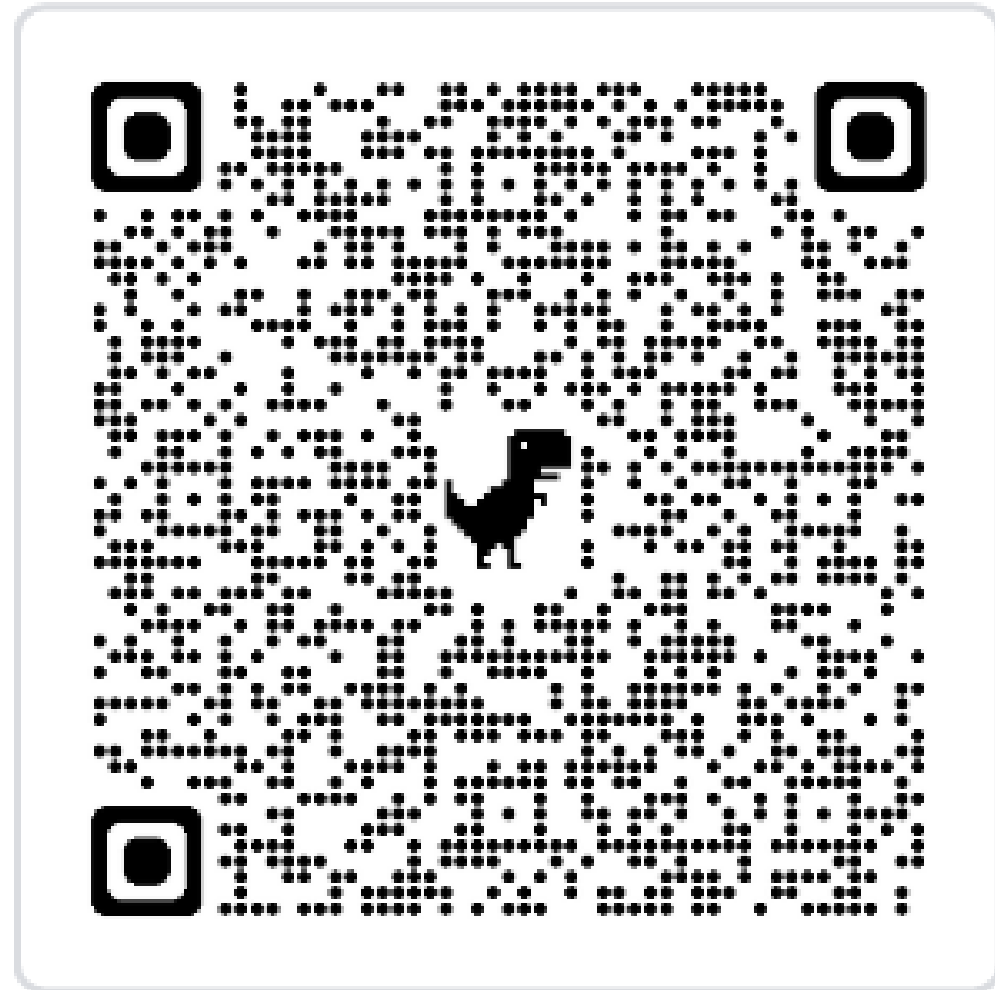 - A Strategy for Assessing and Managing Occupational Exposures. 4th Ed. AIHA Press. 2015.
- **Opinion:**
  - Mulhausen, J. "Faulty Judgment" President's Message. The Synergist. (November 2021). Access HERE
  - Mulhausen, J. "How to Improve Exposure Judgments" President's Message. The Synergist. (December 2021). Access HERE
  - Mulhausen, J. "Standards of Care: Competence PLUS Performance" President's Message. The Synergist. (January 2022). Access HERE
  - Mulhausen, J. "Acknowledging and Addressing Our Blind Spots" President's Message. The Synergist. (March 2022). Access HERE
  - Martin, K., Murphy, M. and Taruru S. "How "Professional" Is Professional Judgment?" Viewpoint. The Synergist. (December 2022). Access HERE
- **Video Webinar:**
  - Mulhausen, J. "Top 10 Imperatives for the AIHA Exposure Risk Management Process." Free from AIHA HERE

Q&A

Access **FREE** Resources Here:

https://www.aiha.org/public-resources/aiha-academic-portal/topic-1---improving-exposure-judgments-an-introduction-to-ih-statistics

THANK YOU

STEVEN D. JAHN, CIH, MBA, FAIHA®

jahnindustrialhygiene@gmail.com

Board for Global EHS Credentialing — Certified Industrial Hygienist

Registered Specialist:
Exposure Decision Analysis

#120102

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